

## CLAIMS

1. A  $12\text{CaO}\cdot 7\text{Al}_2\text{O}_3$  compound comprising: electrons substituted for free oxygen ions at a concentration of  $1\times 10^{18}$  to less than  $1.1\times 10^{21}/\text{cm}^3$  out of free oxygen ions contained in cages at a substitution ratio of the electrons to the free oxygen ions of 2 to 1, the concentration of the electrons being  $2\times 10^{18}$  to less than  $2.2\times 10^{21}/\text{cm}^3$  in the cages, wherein the electrical conductivity at room temperature is in the range of  $10^{-4}$  S/cm to less than  $10^3$  S/cm.

2. A  $12\text{SrO}\cdot 7\text{Al}_2\text{O}_3$  compound comprising: electrons substituted for free oxygen ions at a concentration of  $1\times 10^{18}$  to less than  $1.1\times 10^{21}/\text{cm}^3$  out of free oxygen ions contained in cages at a substitution ratio of the electrons to the free oxygen ions of 2 to 1, the concentration of the electrons being  $2\times 10^{18}$  to less than  $2.2\times 10^{21}/\text{cm}^3$  in the cages, wherein the electrical conductivity at room temperature is in the range of  $10^{-4}$  S/cm to less than  $10^3$  S/cm.

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3. A mixed crystal compound containing  $12\text{CaO}\cdot 7\text{Al}_2\text{O}_3$  and  $12\text{SrO}\cdot 7\text{Al}_2\text{O}_3$ , comprising: electrons substituted for free oxygen ions at a concentration of  $1\times 10^{18}$  to less than  $1.1\times 10^{21}/\text{cm}^3$  out of free oxygen ions contained in cages at a substitution ratio of the electrons to the free oxygen ions

of 2 to 1, the concentration of the electrons being  $2 \times 10^{18}$  to less than  $2.2 \times 10^{21}/\text{cm}^3$  in the cages, wherein the electrical conductivity at room temperature is in the range of  $10^{-4}$  S/cm to less than  $10^3$  S/cm.

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4. An electride  $12\text{CaO} \cdot 7\text{Al}_2\text{O}_3$  compound comprising: electrons that are substituted for almost all the free oxygen ions contained in cages at a substitution ratio of the electrons (referred to as  $e^-$ ) to the oxygen ions of 2 to 1, the electride  $12\text{CaO} \cdot 7\text{Al}_2\text{O}_3$  compound being practically represented by  $[\text{Ca}_{24}\text{Al}_{28}\text{O}_{64}]^{4+}(4e^-)$ .

5. An electride  $12\text{SrO} \cdot 7\text{Al}_2\text{O}_3$  compound comprising: electrons that are substituted for almost all the free oxygen ions contained in cages at a substitution ratio of the electrons to the oxygen ions of 2 to 1, the electride  $12\text{SrO} \cdot 7\text{Al}_2\text{O}_3$  compound being practically represented by  $[\text{Sr}_{24}\text{Al}_{28}\text{O}_{64}]^{4+}(4e^-)$ .

6. A mixed crystal electride compound containing a  $12\text{CaO} \cdot 7\text{Al}_2\text{O}_3$  compound and a  $12\text{SrO} \cdot 7\text{Al}_2\text{O}_3$  compound, comprising: electrons that are substituted for almost all the free oxygen ions contained in cages at a substitution ratio of the electrons to the oxygen ions of 2 to 1, the mixed crystal electride compound being practically

represented by  $[(Ca_{1-x}Sr_x)_{24}Al_{28}O_{64}]^{4+}(4e^-)$ .

7. A method for manufacturing the compound according to one of Claims 1 to 6, comprising the step of: holding a  
5 single crystal  $12CaO \cdot 7Al_2O_3$  compound or a hydrostatic pressure press molded material of a fine powder thereof, a single crystal  $12SrO \cdot 7Al_2O_3$  compound or a hydrostatic pressure press molded material of a fine powder thereof, or  
10 a single crystal of a mixed crystal compound containing a  $12CaO \cdot 7Al_2O_3$  compound and a  $12SrO \cdot 7Al_2O_3$  compound or a hydrostatic pressure press molded material of a fine powder thereof at 600 to 800°C for 4 to less than 240 hours in an alkaline metal vapor or an alkaline earth metal vapor, whereby electrons are substituted for the free oxygen ions.

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8. The method for manufacturing the compound, according to Claim 7, wherein sodium or lithium is used as the alkaline metal, and magnesium or calcium is used as the alkaline earth metal.

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9. A method for manufacturing the compound according to one of Claims 1 to 6, comprising: melting one fine powder of the  $12CaO \cdot 7Al_2O_3$  compound, the  $12SrO \cdot 7Al_2O_3$  compound, and the mixed crystal compound containing a  $12CaO \cdot 7Al_2O_3$  compound and  
25 a  $12SrO \cdot 7Al_2O_3$  compound, followed by cooling and

solidification, whereby electrons are substituted for the free oxygen ions.

10. The method for manufacturing the compound, according to Claim 9, wherein a melt of one fine powder of the  $12\text{CaO}\cdot 7\text{Al}_2\text{O}_3$  compound, the  $12\text{SrO}\cdot 7\text{Al}_2\text{O}_3$ , and the mixed crystal compound containing a  $12\text{CaO}\cdot 7\text{Al}_2\text{O}_3$  compound and a  $12\text{SrO}\cdot 7\text{Al}_2\text{O}_3$  compound is held at more than  $1,550^\circ\text{C}$  to less than  $1,650^\circ\text{C}$  for more than 1 minute to less than 2 hours in a reducing atmosphere, followed by slow cooling to room temperature.

11. The method for manufacturing the compound, according to Claim 10, wherein the reducing atmosphere according to Claim 10 is an atmosphere in a carbon crucible capped by a lid.

12. A method for manufacturing the compound according to one of Claims 1 to 3, comprising the steps of: holding one thin film made of the  $12\text{CaO}\cdot 7\text{Al}_2\text{O}_3$  compound, the  $12\text{SrO}\cdot 7\text{Al}_2\text{O}_3$  compound, or the mixed crystal compound containing a  $12\text{CaO}\cdot 7\text{Al}_2\text{O}_3$  compound and a  $12\text{SrO}\cdot 7\text{Al}_2\text{O}_3$  compound at  $500$  to  $1,400^\circ\text{C}$ , and implanting rare gas ions (Ar, Kr, or Xe) into the thin film of the compound, whereby electrons are substituted for the free oxygen ions.

13. A method for clathrating  $O^-$ ,  $H^-$ , or  $N^-$  having a high concentration of  $1 \times 10^{18}/\text{cm}^3$  or more and a high purity in one of a  $12\text{CaO} \cdot 7\text{Al}_2\text{O}_3$  compound, a  $12\text{SrO} \cdot 7\text{Al}_2\text{O}_3$  compound, and a mixed crystal compound containing a  $12\text{CaO} \cdot 7\text{Al}_2\text{O}_3$  compound and a  $12\text{SrO} \cdot 7\text{Al}_2\text{O}_3$  compound, the method comprising the step of: using the compound according to one of Claims 1 to 6 as a starting material.

14. A compound clathrating  $N^-$  ions at a concentration of  $1 \times 10^{18}/\text{cm}^3$  or more, the compound being one of the  $12\text{CaO} \cdot 7\text{Al}_2\text{O}_3$  compound, the  $12\text{SrO} \cdot 7\text{Al}_2\text{O}_3$  compound, and the mixed crystal compound containing a  $12\text{CaO} \cdot 7\text{Al}_2\text{O}_3$  compound and a  $12\text{SrO} \cdot 7\text{Al}_2\text{O}_3$  compound, which is produced by the method according to Claim 13.

15. An electron emission material comprising: the compound according to one of Claims 1 to 6.

16. A reducing material comprising: the compound according to one of Claims 1 to 6.